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(54) **POWER SUPPLY APPARATUS AND METHOD, AND USER EQUIPMENT**

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H02J 7/04	(2006.01)
G05F 1/00	(2006.01)
G05F 5/00	(2006.01)
G06F 1/28	(2006.01)

(Continued)

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(58) **Field of Classification Search**

CPC H02J 7/0031; H02J 2007/004; H02J 2007/0037; Y02E 60/12; H01M 10/48

USPC 320/134, 137, 140; 323/222, 269, 282

See application file for complete search history.

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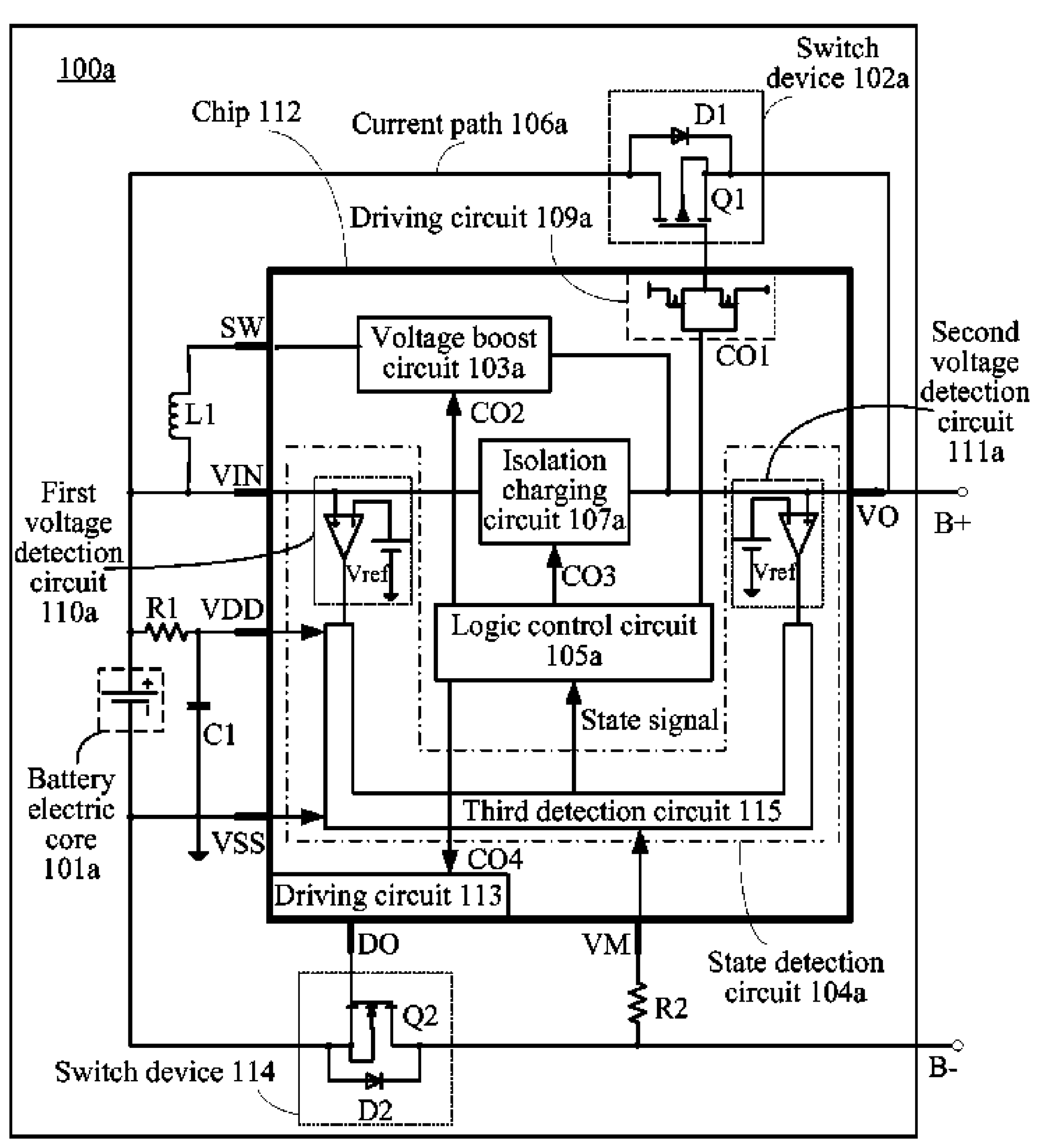
(57) **ABSTRACT**

Embodiments of the present invention provide a power supply apparatus and method, and a user equipment. In the embodiments of the present invention, charging protection for the battery electric core and a bypass function for the voltage boost circuit can be implemented through control that is performed on the switch device by the logic control circuit, so that additional impedance can be reduced and working efficiency can be improved.

16 Claims, 5 Drawing Sheets



(51) **Int. Cl.**

H01M 10/42	(2006.01)
H01M 10/48	(2006.01)

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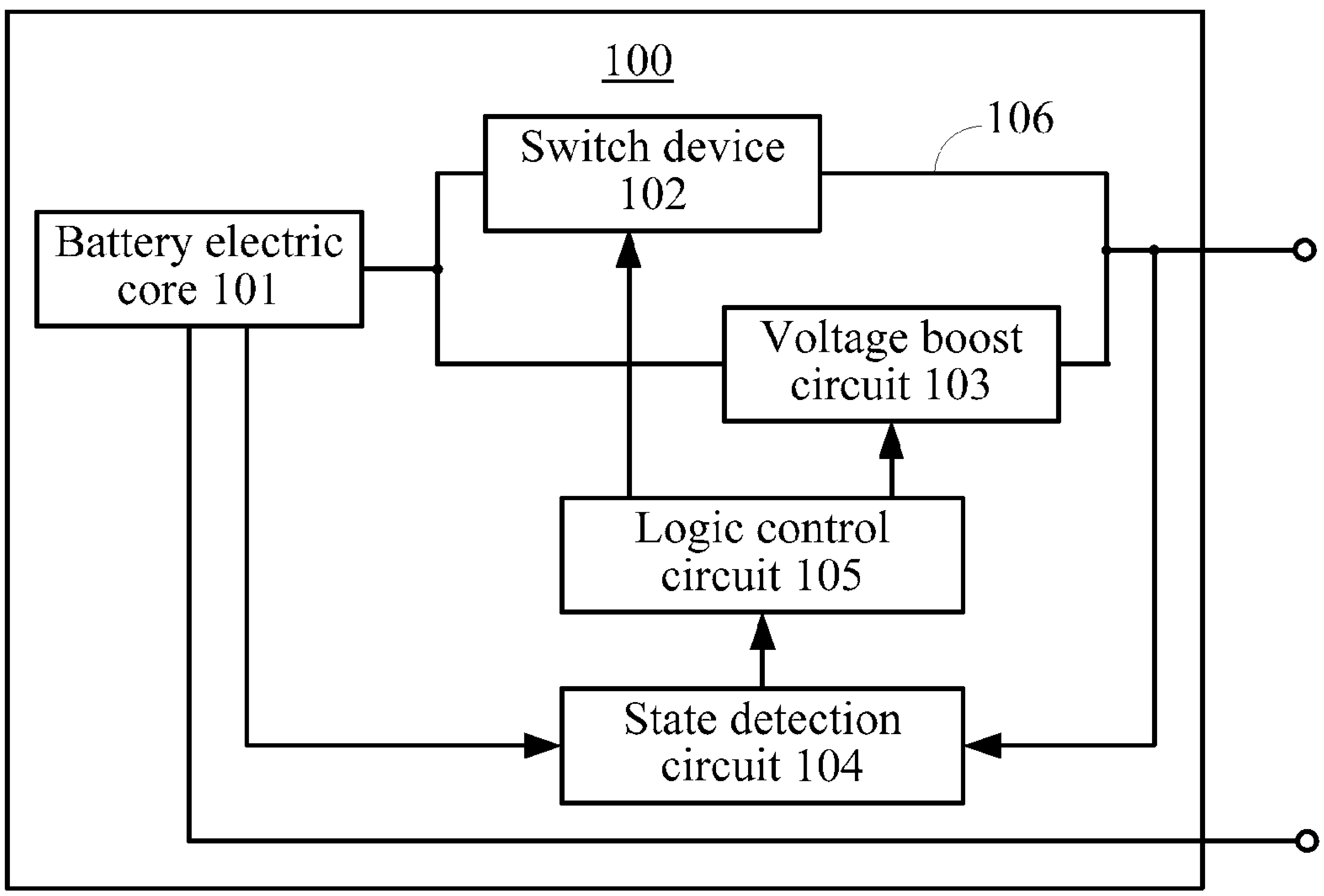
100
Switch device 102
106
Battery electric core 101
Voltage boost circuit 103
Logic control circuit 105
State detection circuit 104

FIG. 1

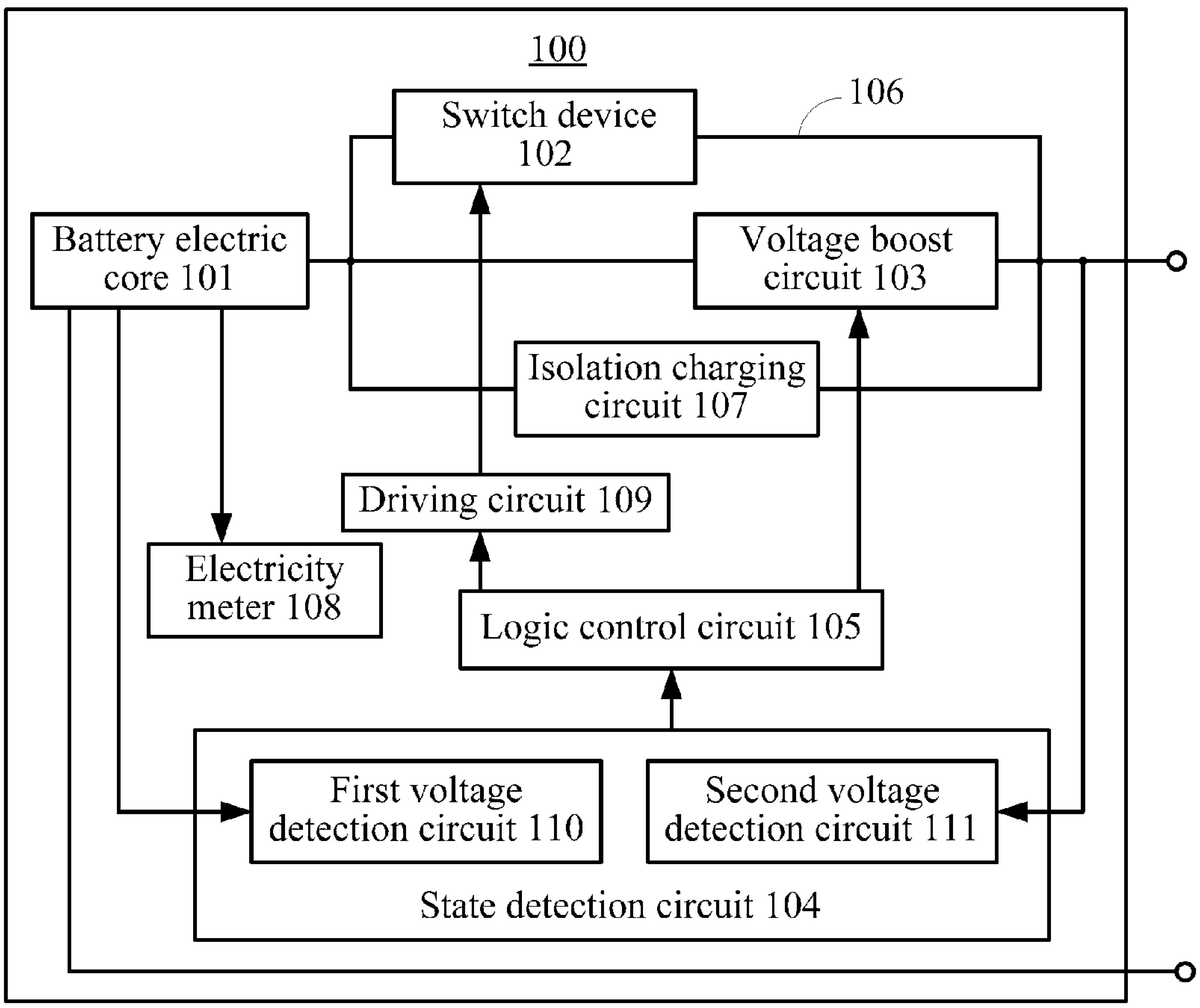
100
Switch device 102
106
Battery electric core 101
Voltage boost circuit 103
Isolation charging circuit 107
Driving circuit 109
Electricity meter 108
Logic control circuit 105
First voltage detection circuit 110
Second voltage detection circuit 111
State detection circuit 104

FIG. 2

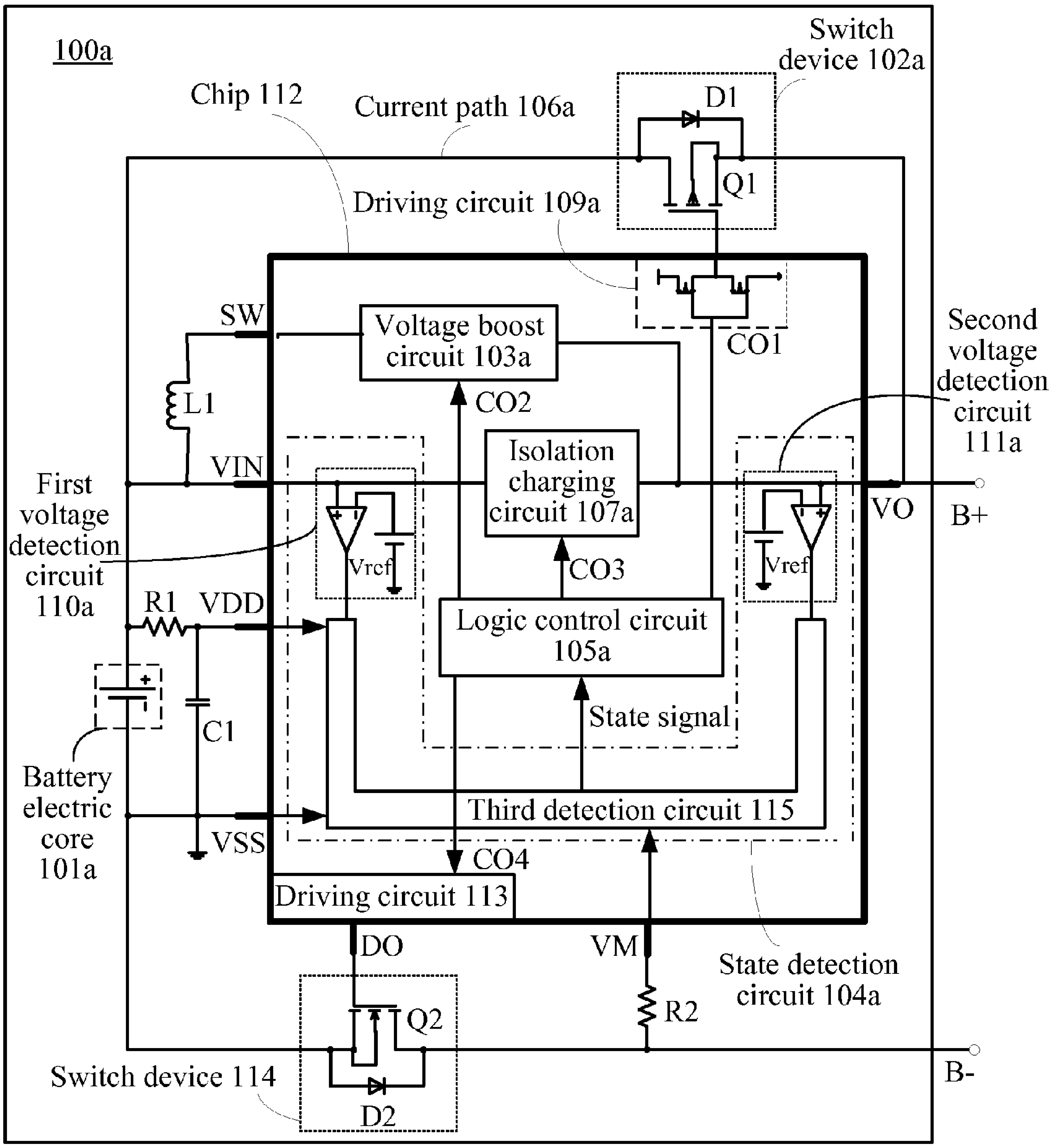
100a
Switch device 102a
Chip 112
Current path 106a
D1
Q1
Driving circuit 109a
SW
Voltage boost circuit 103a
CO1
Second voltage detection circuit 111a
L1
CO2
VIN
Isolation charging circuit 107a
First voltage detection circuit 110a
VO
B+
Vref
CO3
Vref
R1
VDD
Logic control circuit 105a
State signal
C1
Battery electric core 101a
Third detection circuit 115
VSS
CO4
Driving circuit 113
DO
VM
State detection circuit 104a
Q2
R2
Switch device 114
B-
D2

FIG. 3

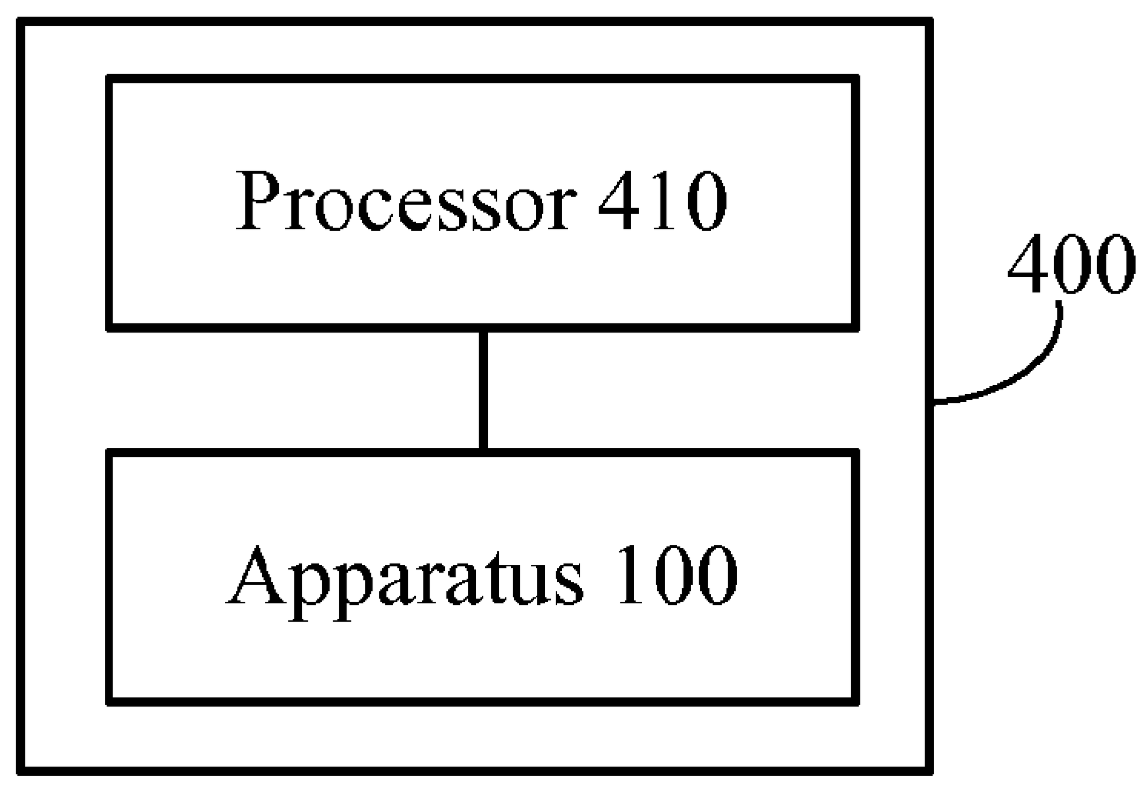
Processor 410
400
Apparatus 100

FIG. 4

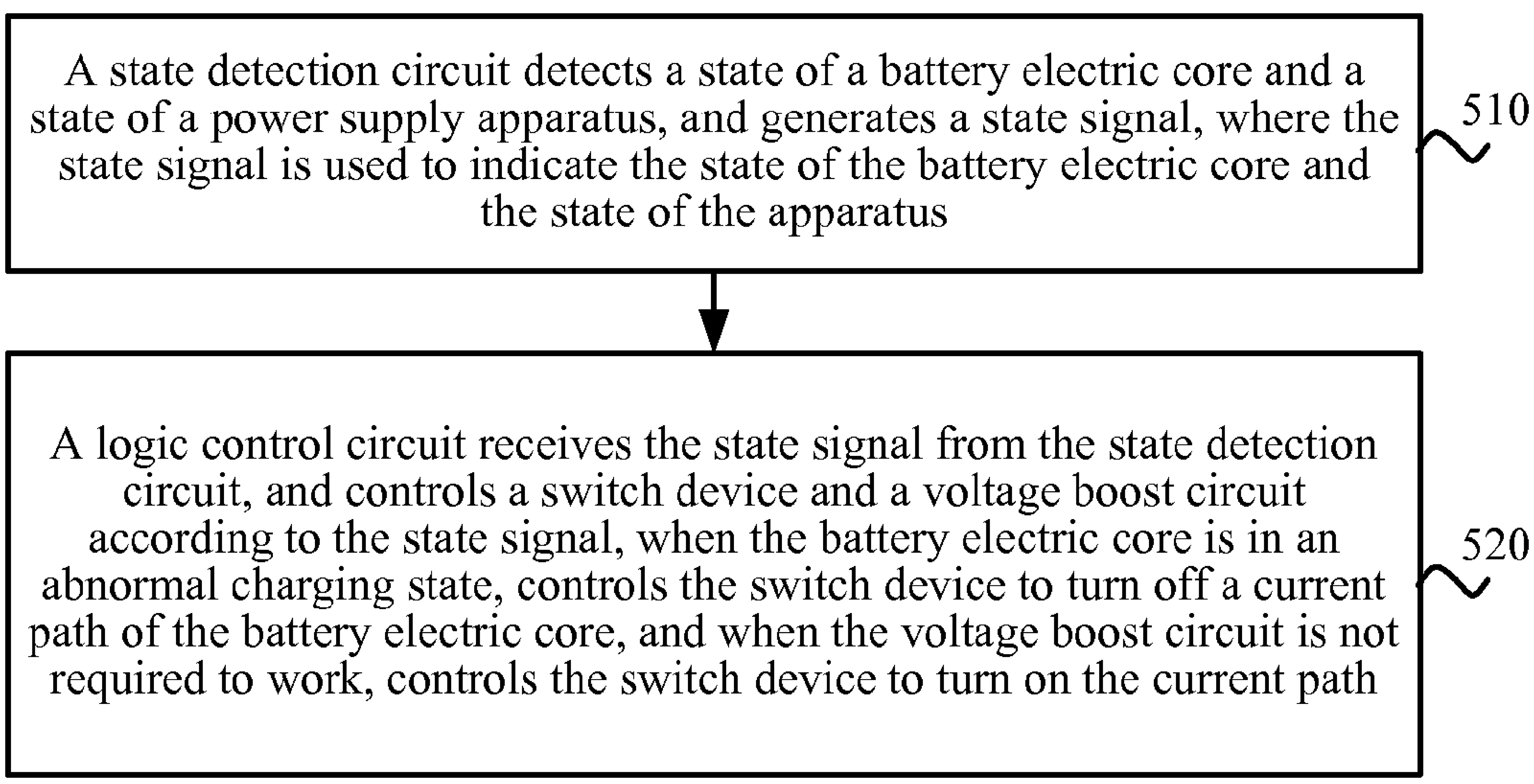
A state detection circuit detects a state of a battery electric core and a state of a power supply apparatus, and generates a state signal, where the state signal is used to indicate the state of the battery electric core and the state of the apparatus
510
A logic control circuit receives the state signal from the state detection circuit, and controls a switch device and a voltage boost circuit according to the state signal, when the battery electric core is in an abnormal charging state, controls the switch device to turn off a current path of the battery electric core, and when the voltage boost circuit is not required to work, controls the switch device to turn on the current path
520

FIG. 5

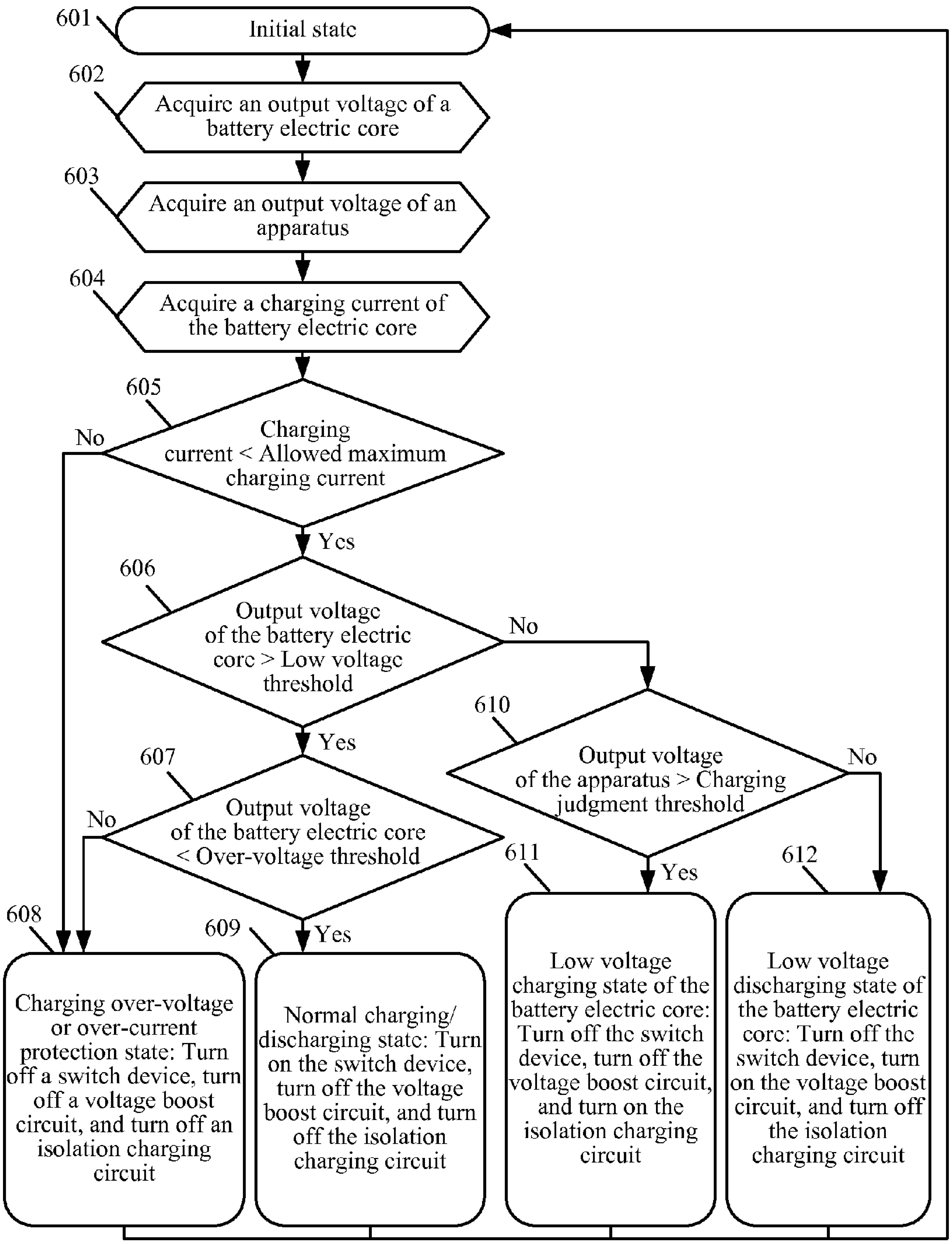
601
Initial state
602
Acquire an output voltage of a battery electric core
603
Acquire an output voltage of an apparatus
604
Acquire a charging current of the battery electric core
605
Charging current < Allowed maximum charging current
No
Yes
606
Output voltage of the battery electric core > Low voltage threshold
No
Yes
610
Output voltage of the apparatus > Charging judgment threshold
No
Yes
607
Output voltage of the battery electric core < Over-voltage threshold
No
Yes
608
Charging over-voltage or over-current protection state: Turn off a switch device, turn off a voltage boost circuit, and turn off an isolation charging circuit
609
Normal charging/ discharging state: Turn on the switch device, turn off the voltage boost circuit, and turn off the isolation charging circuit
611
Low voltage charging state of the battery electric core: Turn off the switch device, turn off the voltage boost circuit, and turn on the isolation charging circuit
612
Low voltage discharging state of the battery electric core: Turn off the switch device, turn on the voltage boost circuit, and turn off the isolation charging circuit

FIG. 6

POWER SUPPLY APPARATUS AND METHOD, AND USER EQUIPMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of International Patent Application No. PCT/CN2012/079777, filed on Aug. 7, 2012, which is hereby incorporated by reference in their entireties.

FIELD OF THE INVENTION

The present invention relates to the field of electronics, and in particular, to a power supply apparatus and method, and a user equipment.

BACKGROUND OF THE INVENTION

In the design of mobile communication terminals in the prior art, shutdown voltages of batteries are mostly set to a value ranging from 3.3 V to 3.5 V. However, with the progress of a battery technology and application of a new material, a working voltage of a battery can be lower. In this way, more residual electricity exists in a low voltage range.

In order to fully utilize the capacity of a battery in a low voltage range, generally, voltage boost needs to be performed when the battery is at a low voltage, so as to ensure normal work of devices in a circuit. At present, multiple switch devices, for example, metal-oxide-semiconductor field-effect transistors (Metal-Oxide-Semiconductor Field-Effect Transistors, MOSFETs), are generally required in a common voltage boost circuit to implement voltage boost and a bypass mode when the voltage boost is not required. Because a switch device has direct current impedance, large impedance is introduced into a working path, thereby reducing overall working efficiency of a system and deteriorating a loading capability of a battery.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide a power supply apparatus and method, and a user equipment, so that additional impedance can be reduced and working efficiency can be improved.

In a first aspect, a power supply apparatus is provided and includes: a battery electric core, a switch device, a voltage boost circuit, a state detection circuit, and a logic control circuit, where the switch device is connected to a current path of the battery electric core; the voltage boost circuit is connected in parallel to the current path, and is configured to boost an output voltage of the battery electric core; the state detection circuit is configured to detect a state of the battery electric core and a state of the apparatus, and generate a state signal, where the state signal is used to indicate the state of the battery electric core and the state of the apparatus; and the logic control circuit is configured to receive the state signal from the state detection circuit, and control the switch device and the voltage boost circuit according to the state signal, when the battery electric core is in an abnormal charging state, control the switch device to turn off the current path, and when the voltage boost circuit is not required to work, control the switch device to turn on the current path.

In combination with the first aspect, in a first possible implementation manner, the logic control circuit is specifically configured to, when the state signal indicates that the battery electric core is in an over-voltage state or when the state signal indicates that the battery electric core is in an over-current charging state, turn off the voltage boost circuit and control the switch device to turn off the current path.

In combination with the first aspect, in a second possible implementation manner, the logic control circuit is specifically configured to, when the state signal indicates that the output voltage of the battery electric core is smaller than a voltage threshold and indicates that an output voltage of the apparatus is smaller than the voltage threshold, turn on the voltage boost circuit and control the switch device to turn off the current path.

In combination with the first aspect, in a third possible implementation manner, the logic control circuit is specifically configured to, when the state signal indicates that the output voltage of the battery electric core is greater than or equal to a voltage threshold and indicates that an output voltage of the apparatus is greater than or equal to the voltage threshold, turn off the voltage boost circuit and control the switch device to turn on the current path.

In combination with the first aspect, or the first possible implementation manner of the first aspect, or the second possible implementation manner of the first aspect, or the third possible implementation manner of the first aspect, in a fourth possible implementation manner, the apparatus further includes: a driving circuit, which is connected to the switch device, where the driving circuit adopts a field-effect transistor push-pull structure; and the logic control circuit is specifically configured to control the switch device through the driving circuit.

In combination with the first aspect, or the first possible implementation manner of the first aspect, or the second possible implementation manner of the first aspect, or the third possible implementation manner of the first aspect, or the fourth possible implementation manner of the first aspect, in a fifth possible implementation manner, the apparatus further includes an isolation charging circuit, which is connected in parallel to the current path and the voltage boost circuit, and configured to charge the battery electric core and isolate the output voltage of the battery electric core from the output voltage of the apparatus; and the logic control circuit is further configured to control the isolation charging circuit according to the state signal.

In combination with the fifth possible implementation manner of the first aspect, in a sixth possible implementation manner, the logic control circuit is specifically configured to, when the state signal indicates that the output voltage of the battery electric core is smaller than a voltage threshold and indicates that the output voltage of the apparatus is greater than or equal to the voltage threshold, turn on the isolation charging circuit, turn off the voltage boost circuit, and control the switch device to turn off the current path.

In combination with the fifth possible implementation manner of the first aspect or the sixth possible implementation manner of the first aspect, in a seventh possible implementation manner, the voltage boost circuit, the state detection circuit, the logic control circuit, and the isolation charging circuit are integrated in one chip.

In combination with the first aspect, or the first possible implementation manner of the first aspect, or the second possible implementation manner of the first aspect, or the third possible implementation manner of the first aspect, or the fourth possible implementation manner of the first aspect, or the fifth possible implementation manner of the first aspect, or the sixth possible implementation manner of the first aspect, or the seventh possible implementation manner of the first aspect, in an eighth possible implementation manner, the state detection circuit includes a first voltage detection circuit and a second voltage detection circuit, where the first voltage detection circuit is configured to detect the output voltage of the battery electric core and compare the output voltage of the battery electric core with a voltage threshold; and the second voltage detection circuit is configured to detect the output voltage of the apparatus and compare the output voltage of the apparatus with the voltage threshold.

In a second aspect, a user equipment is provided and includes: a processor and the apparatus described in the first aspect, or in combination with the first aspect, the first possible implementation manner of the first aspect, the second possible implementation manner of the first aspect, the third possible implementation manner of the first aspect, the fourth possible implementation manner of the first aspect, the fifth possible implementation manner of the first aspect, the sixth possible implementation manner of the first aspect, the seventh possible implementation manner of the first aspect, or the eighth possible implementation manner of the first aspect, where the apparatus is configured to supply power to the processor.

In a third aspect, a power supply method is provided and includes: detecting, by a state detection circuit, a state of a battery electric core and a state of a power supply apparatus, and generating a state signal, where the state signal is used to indicate the state of the battery electric core and the state of the apparatus; and receiving, by a logic control circuit, the state signal from the state detection circuit, and controlling a switch device and a voltage boost circuit according to the state signal, when the battery electric core is in an abnormal charging state, controlling the switch device to turn off a current path of the battery electric core, and when the voltage boost circuit is not required to work, controlling the switch device to turn on the current path, where the apparatus includes the state detection circuit, the battery electric core, the voltage boost circuit, the switch device, and the logic control circuit, where the switch device is connected in the current path, the voltage boost circuit is connected in parallel to the current path, and the voltage boost circuit is configured to boost an output voltage of the battery electric core.

In combination with the third aspect, in a first possible implementation manner, when the state signal indicates that the battery electric core is in an over-voltage state or when the state signal indicates that the battery electric core is in an over-current charging state, the logic control circuit turns off the voltage boost circuit and controls the switch device to turn off the current path.

In combination with the third aspect, in a second possible implementation manner, when the state signal indicates that the output voltage of the battery electric core is greater than or equal to a voltage threshold and indicates that an output voltage of the apparatus is greater than or equal to the voltage threshold, the logic control circuit turns off the voltage boost circuit and controls the switch device to turn on the current path.

In the embodiments of the present invention, when the battery electric core is in an abnormal charging state, the logic control circuit can control the switch device to turn off the current path, and when the voltage boost circuit is not required to work, the logic control circuit can control the switch device to turn on the current path. Therefore, charging protection for the battery electric core and a bypass function for the voltage boost circuit can be implemented through control that is performed on the switch device by the logic control circuit, without through multiple switch devices. Therefore, the number of switch devices can be reduced, so that additional impedance can be reduced and working efficiency can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

To illustrate the technical solutions in the embodiments of the present invention more clearly, the accompanying drawings required for describing the embodiments of the present invention are described briefly in the following. Apparently, the accompanying drawings in the following description merely show some embodiments of the present invention, and persons of ordinary skill in the art may also derive other drawings from these accompanying drawings without creative efforts.

FIG. **1** is a schematic block diagram of a power supply apparatus according to an embodiment of the present invention;

FIG. **2** is a schematic block diagram of a power supply apparatus according to an embodiment of the present invention;

FIG. **3** is a schematic block diagram of an example of a power supply apparatus according to an embodiment of the present invention;

FIG. **4** is a schematic block diagram of a user equipment according to an embodiment of the present invention;

FIG. **5** is a schematic flowchart of a power supply method according to an embodiment of the present invention; and

FIG. **6** is a schematic flowchart of a process of a power supply method according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The technical solutions in the embodiments of the present invention are clearly and completely described in the following with reference to the accompanying drawings in the embodiments of the present invention. Apparently, the embodiments to be described are merely a part rather than all of the embodiments of the present invention. All other embodiments obtained by persons of ordinary skill in the art based on the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

FIG. **1** is a schematic block diagram of a power supply apparatus according to an embodiment of the present invention.

As shown in FIG. **1**, an apparatus **100** may include a battery electric core **101**, a switch device **102**, a voltage boost circuit **103**, a state detection circuit **104**, and a logic control circuit **105**.

The switch device **102** is connected in a current path **106** of the battery electric core **101**. The voltage boost circuit **103** is connected in parallel to the current path **106**, and is configured to boost an output voltage of the battery electric core **101**. The state detection circuit **104** is configured to detect a state of the battery electric core **101** and a state of the apparatus **100**, and generate a state signal, where the state signal is used to indicate the state of the battery electric core **101** and the state of the apparatus **100**. The logic control circuit **105** is configured to receive the state signal from the state detection circuit **104**, and control the switch device **102** and the voltage boost circuit **103** according to the state signal, when the battery electric core **101** is in an abnormal charging state, control the switch device **102** to turn off the current path **106**, and when the voltage boost circuit **103** is not required to work, control the switch device **102** to turn on the current path **106**.

In this embodiment of the present invention, the logic control circuit **105** controls the switch device **102** and the voltage boost circuit **103** according to the state signal. In one aspect, charging protection for the battery electric core **101** can be implemented. When the battery electric core **101** is in an abnormal charging state, the logic control circuit **105** may control the switch device **102** to turn off the current path **106**, so as to perform charging protection on the battery electric core **101**. In another aspect, switching between the current path **106** where the switch device **102** is located and the voltage boost circuit **103** can be performed. That is, when the output voltage of the battery electric core **101** needs to be boosted, switching to the voltage boost circuit **103** may be performed, so that an output voltage provided by the apparatus **100** enables a load to work normally; and when the output voltage of the battery electric core **101** does not need to be boosted, the switch device **102** may be controlled to turn on the current path **106**.

In the prior art, charging protection for a battery electric core is implemented through one switch device in a charging protection circuit, and a bypass function for a voltage boost circuit is implemented through one switch device in a voltage boost module, and a serial connection relation exists between the charging protection circuit and the voltage boost module, so that impedance generated by a switch device in a discharging loop is large, thereby lowering working efficiency.

It can be seen that, in this embodiment of the present invention, protection control for the battery electric core **101** and a bypass of the voltage boost circuit when voltage boost is not required can be implemented through one switch device, without requiring multiple switch devices. Therefore, the number of switch devices is reduced, so that additional impedance introduced by the switch devices can be reduced and working efficiency can be improved.

In this embodiment of the present invention, when the battery electric core is in an abnormal charging state, the logic control circuit can control the switch device to turn off the current path, and when the voltage boost circuit is not required to work, the logic control circuit can control the switch device to turn on the current path. Therefore, charging protection for the battery electric core and a bypass function for the voltage boost circuit can be implemented through control that is performed on the switch device by the logic control circuit, without through multiple switch devices. Therefore, the number of switch devices can be reduced, so that additional impedance can be reduced and working efficiency can be improved.

In addition, because the number of switch devices can be reduced, space of a printed circuit board (Printed Circuit Board, PCB) can be saved, so that costs of a device and a single board can be lowered.

Optionally, as an embodiment, when the state signal indicates that the battery electric core **101** is in an over-voltage state or when the state signal indicates that the battery electric core **101** is in an over-current charging state, the logic control circuit **105** may turn off the voltage boost circuit **103** and control the switch device **102** to turn off the current path **106**. The logic control circuit **105** can implement protection for the battery electric core **101** by turning off the voltage boost circuit **103** and the current path **106**.

Optionally, as another embodiment, when the state signal indicates that the output voltage of the battery electric core **101** is smaller than a voltage threshold and indicates that the output voltage of the apparatus **100** is smaller than the voltage threshold, the logic control circuit **105** may turn on the voltage boost circuit **103** and control the switch device **102** to turn off the current path **106**.

Optionally, as another embodiment, when the state signal indicates that the output voltage of the battery electric core **101** is greater than or equal to a voltage threshold and indicates that the output voltage of the apparatus **100** is greater than or equal to the voltage threshold, the logic control circuit **105** may turn off the voltage boost circuit **103** and control the switch device **102** to turn on the current path **106**.

Optionally, as another embodiment, as shown in FIG. **2**, the apparatus **100** may further include a driving circuit **109**. The driving circuit **109** may be connected to the switch device **102**. The driving circuit **109** may adopt a field-effect transistor push-pull structure. The logic control circuit **105** controls the switch device **102** through the driving circuit **109**. In this embodiment of the present invention, because the driving circuit adopts the field-effect transistor push-pull structure, the driving circuit has a high response speed and a strong driving capability.

Optionally, as another embodiment, as shown in FIG. **2**, the apparatus **100** may further include an isolation charging circuit **107**. The isolation charging circuit **107** may be connected in parallel to the current path **106** and the voltage boost circuit **103**, and is configured to charge the battery electric core **101** and isolate the output voltage of the battery electric core **101** from the output voltage of the apparatus **100**. The logic control circuit **105** may further control the isolation charging circuit **107** according to the state signal.

Optionally, as another embodiment, when the state signal indicates that the output voltage of the battery electric core **101** is smaller than a voltage threshold and indicates that the output voltage of the apparatus **100** is greater than or equal to the voltage threshold, the logic control circuit **105** may turn on the isolation charging circuit **107**, turn off the voltage boost circuit **103**, and control the switch device **102** to turn off the current path **106**. The battery electric core **101** may be charged by turning on the isolation charging circuit **107**. In addition, Because the isolation charging circuit **107** has an isolation function and the output voltage of the battery electric core **101** is smaller than the output voltage of the apparatus **100**, in a process of charging the battery electric core **101**, it can be ensured that the output voltage of the apparatus **100** is not pulled down by the output voltage of the battery electric core **101**, so that normal work of the load of the apparatus **100** can be ensured.

Optionally, as another embodiment, the voltage boost circuit **103**, the state detection circuit **104**, the logic control circuit **105**, and the isolation charging circuit **107** may be integrated in one chip. In addition, the voltage boost circuit **103**, the state detection circuit **104**, the logic control circuit **105**, and the isolation charging circuit **107** may also not be integrated in one chip, which is not limited in this embodiment of the present invention.

Optionally, as another embodiment, the state detection circuit **104** may include a first voltage detection circuit **110** and a second voltage detection circuit **111**.

The first voltage detection circuit **110** may be configured to detect the output voltage of the battery electric core **101** and compare the output voltage of the battery electric core **101** with a voltage threshold.

The second voltage detection circuit **111** may be configured to detect the output voltage of the apparatus **100** and compare the output voltage of the apparatus **100** with the voltage threshold.

Optionally, as another embodiment, the switch device **102** may include an MOSFET and a parasitic diode that is connected in parallel to the MOSFET.

Optionally, as another embodiment, as shown in FIG. **2**, the apparatus **100** may further include an electricity meter **108**, configured to detect the amount of electricity of the battery electric core **101**.

Optionally, as another embodiment, the electricity meter **108**, the voltage boost circuit **103**, the state detection circuit **104**, and the logic control circuit **105** may be integrated in one chip.

In addition, the electricity meter **108**, the voltage boost circuit **103**, the state detection circuit **104**, the logic control circuit **105**, and the isolation charging circuit **107** may also be integrated in one chip, which is not limited in this embodiment of the present invention.

In this embodiment of the present invention, when the battery electric core is in an abnormal charging state, the logic control circuit can control the switch device to turn off the current path, and when the voltage boost circuit is not required to work, the logic control circuit can control the switch device to turn on the current path. Therefore, charging protection for the battery electric core and a bypass function for the voltage boost circuit can be implemented through control that is performed on the switch device by the logic control circuit, without through multiple switch devices. Therefore, the number of switch devices can be reduced, so that additional impedance can be reduced and working efficiency can be improved.

In addition, because the number of switch devices can be reduced, space of a PCB can be saved, so that costs of a device and a single board can be lowered.

The embodiment of the present invention is described in detail in the following with reference to specific examples. It should be noted that the examples are used only to help persons skilled in the art have a better understanding of the embodiment of the present invention rather than to limit the scope of the embodiment of the present invention.

FIG. **3** is a schematic block diagram of an example of a power supply apparatus according to an embodiment of the present invention.

As shown in FIG. **3**, an apparatus **100*a*** may include a battery electric core **101*a***, a switch device **102*a***, a voltage boost circuit **103*a***, a state detection circuit **104*a***, a logic control circuit **105*a***, an isolation charging circuit **107*a***, a driving circuit **109*a***, and a driving circuit **113**.

It should be noted that, in FIG. **3**, the voltage boost circuit **103*a***, the state detection circuit **104*a***, the logic control circuit **105*a***, the isolation charging circuit **107*a***, the driving circuit **109*a***, and the driving circuit **113** may be integrated in a chip **112**. However, in this embodiment of the present invention, the voltage boost circuit **103*a***, the state detection circuit **104*a***, the logic control circuit **105*a***, the isolation charging circuit **107*a***, the driving circuit **109*a***, and the driving circuit **113** may also not be integrated in one chip, which is not limited in this embodiment of the present invention.

The switch device **102*a*** is connected in a current path **106*a*** of the battery electric core **101*a***. The switch device **102*a*** may include Q**1** and D**1**, where Q**1** may be an MOSFET, and D**1** may be a parasitic diode.

Both the voltage boost circuit **103*a*** and the isolation charging circuit **107*a*** may be connected in parallel to the current path **106*a***. The voltage boost circuit **103*a*** may be configured to boost an output voltage of the battery electric core **101*a***. The isolation charging circuit **107*a*** may be configured to charge the battery electric core **101*a*** and isolate a voltage at an output end VIN of the battery electric core **101*a*** from a voltage at an output end VO of the apparatus **100*a***.

The state detection circuit **104*a*** may be configured to detect a state of the battery electric core **101*a*** and a state of the apparatus **100*a***. The state detection circuit **104*a*** may include a first voltage detection circuit **110*a***, a second voltage detection circuit **111*a***, and a third detection circuit **115**. For example, as shown in FIG. **3**, the first voltage detection circuit **110*a*** may detect the voltage at the output end VIN of the battery electric core **101*a*** and compare the voltage at the output end VIN with a voltage threshold. The second voltage detection circuit **111*a*** may detect the voltage at the output end VO of the apparatus **100*a*** and compare the voltage at the output end VO with the voltage threshold. The third detection circuit **115** may detect an end VDD of a resistor R**1** and an end VM of a resistor R**2**. The third detection circuit **115** may further generate a state signal according to a detection result of the third detection circuit **115**, a detection result of the first voltage detection circuit **110*a***, and a detection result of the second voltage detection circuit **111*a***, and send the state signal to the logic control circuit **105*a***.

The logic control circuit **105*a*** may receive the state signal from the state detection circuit **104*a*** and may control the switch device **102*a***, the voltage boost circuit **103*a***, and the isolation charging circuit **107*a*** according to the state signal. When the battery electric core **101*a*** is in an abnormal charging state, the logic control circuit **105*a*** may control the switch device **102*a*** to turn off the current path **106*a***, so as to perform charging protection on the battery electric core **101*a***. When the voltage boost circuit **103*a*** is not required to work, the logic control circuit **105*a*** may control the switch device **102*a*** to turn on the current path **106*a***, so as to bypass the voltage boost circuit **103*a***.

For example, as shown in FIG. **3**, according to the state signal, the logic control circuit **105*a*** may generate a first control signal CO**1** to control the switch device **102*a*** through the driving circuit **109*a***, may generate a second control signal CO**2** to control the voltage boost circuit **103*a***, and may generate a third control signal CO**3** to control the isolation charging circuit **107*a***.

Optionally, when the state signal indicates that the battery electric core **101*a*** is in an over-voltage state or when the state signal indicates that the battery electric core **101*a*** is in an over-current charging state, the logic control circuit **105*a*** may generate a first control signal CO**1** to control the switch device **102*a*** to turn off the current path **106*a***, and generate a second control signal CO**2** to turn off the voltage boost circuit **103*a***, and may further generate a third control signal CO**3** to turn off the isolation charging circuit **107*a***. In this way, the protection for the battery electric core **101*a*** can be implemented by turning off each current path.

Optionally, when the state signal indicates that the voltage at the output end VIN of the battery electric core **101*a*** is smaller than a voltage threshold and indicates that the voltage at the output end VO of the apparatus **100*a*** is smaller than the voltage threshold, the logic control circuit **105*a*** may generate a first control signal CO**1** to control the switch device **102*a*** to turn off the current path **106*a***, and generate a second control signal CO**2** to turn on the voltage boost circuit **103*a***, and may further generate a third control signal CO**3** to turn off the isolation charging circuit **107*a***.

The voltage threshold may be preset according to a factor such as performance of the battery electric core, which is not limited in this embodiment of the present invention. For example, for a battery electric core of a mobile communication terminal, a voltage threshold may be set to a value ranging from 3.3 V to 3.5 V.

When the voltage at the output end VIN of the battery electric core **101*a*** is smaller than the voltage threshold and the voltage at the output end VO of the apparatus **100*a*** is smaller than the voltage threshold, it may indicate that the battery electric core **101*a*** is in a low voltage range. When the battery electric core **101*a*** is in the low voltage range, it may cause that the voltage at the output end VO of the apparatus **100*a*** is reduced. In order to ensure normal work of a load, the voltage at the output end VIN of the battery electric core **101**_a_ may be boosted by turning on the voltage boost circuit **103**_a_.

Optionally, when the state signal indicates that the voltage at the output end VIN of the battery electric core **101**_a_ is greater than or equal to a voltage threshold and indicates that the voltage at the output end VO of the apparatus **100**_a_ is greater than or equal to the voltage threshold, the logic control circuit **105**_a_ may generate a first control signal CO**1** to control the switch device **102**_a_ to turn on the current path **106**_a_, and generate a second control signal CO**2** to turn off the voltage boost circuit **103**_a_, and in addition, may further generate a third control signal CO**3** to turn off the isolation charging circuit **107**_a_.

When the voltage at the output end VIN of the battery electric core **101**_a_ is greater than or equal to the voltage threshold and the voltage at the output end VO of the apparatus **100**_a_ is greater than or equal to the voltage threshold, it may indicate that the battery electric core **101**_a_ is in a high voltage range. When the battery electric core **101**_a_ is in the high voltage range, the voltage at the output end VO of the apparatus **100**_a_ can ensure normal work of a load without boosting the output voltage of the battery electric core **101**_a_. Therefore, the current path **106**_a_ may be turned on and the voltage boost circuit **103**_a_ may be turned off.

Optionally, when the state signal indicates that the voltage at the output end VIN of the battery electric core **101**_a_ is smaller than a voltage threshold and indicates that the voltage at the output end VO of the apparatus **100**_a_ is greater than or equal to the voltage threshold, the logic control circuit **105**_a_ may generate a third control signal CO**3** to turn on the isolation charging circuit **107**_a_, generate a first control signal CO**1** to control the switch device **102**_a_ to turn off the current path **106**_a_, and generate a second control signal CO**2** to turn off the voltage boost circuit **103**_a_.

Because the isolation charging circuit **107**_a_ has an isolation function and the output voltage of the battery electric core **101**_a_ is smaller than the output voltage of the apparatus **100**_a_, in a process of charging the battery electric core **101**_a_, it can be ensured that the output voltage of the apparatus **100**_a_ is not pulled down by the output voltage of the battery electric core **101**_a_, so that normal work of the load of the apparatus **100**_a_ can be ensured.

An example of a logic truth table of a logic control module **150** is shown in Table 1.

TABLE 1

Logic truth table of logic control module 150

State Signal			Control Signal		
STA1	STA2	STA3	CO1	CO2	CO3
1	1	0	1	0	0
0	0	0	0	1	0
0	1	0	0	0	1
X	X	1	0	0	0
H	X	0	0	0	0

In Table 1, a state signal may include a first state signal STA**1**, a second state signal STA**2**, and a third state signal STA**3**.

When STA**1** is "1", it may indicate that the output voltage of the battery electric core **101**_a_ is greater than or equal to a voltage threshold, when STA**1** is "0", it may indicate that the output voltage of the battery electric core **101**_a_ is smaller than the voltage threshold, when STA**1** is "X", it may indicate that a control signal is irrelevant with STA**1**, and when STA**1** is "H", it may indicate that the battery electric core **101**_a_ is in an over-voltage state.

When STA**2** is "1", it may indicate that the output voltage of the apparatus **100**_a_ is greater than or equal to the voltage threshold, when STA**2** is "0", it may indicate that the output voltage of the apparatus **100**_a_ is smaller than the voltage threshold, and when STA**2** is "X", it may indicate that a control signal is irrelevant with STA**2**.

When STA**3** is "1", it may indicate that the battery electric core **101**_a_ is in an over-current charging state, and when STA**3** is "1", it may indicate that the battery electric core **101**_a_ is in a normal charging current state.

When CO**1** is "1", it may indicate that the current path **106**_a_ is turned on, and when the CO**1** is "0", it may indicate that the current path **106**_a_ is turned off.

When CO**2** is "1", it may indicate that the voltage boost circuit **103**_a_ is turned on, and when CO**2** is "0", it may indicate that the voltage boost circuit **103**_a_ is turned off.

When CO**3** is "1", it may indicate that the isolation charging circuit **107**_a_ is turned on, and when CO**3** is "0", it may indicate that the isolation charging circuit **107**_a_ is turned off.

In addition, the apparatus **100**_a_ may further include a switch device **114**. The switch device **114** may include Q**2** and D**2**, where Q**2** may be an MOSFET, and D**2** may be a parasitic diode.

The logic control circuit **105**_a_ may further control the switch device **114** to perform discharging protection on the battery electric core **101**_a_.

For example, as shown in FIG. **3**, the logic control circuit **105**_a_ may further generate a fourth control signal CO**4** to control the switch device **114** through the driving circuit **113**.

In this embodiment of the present invention, when the battery electric core is in an abnormal charging state, the logic control circuit can control the switch device to turn off the current path, and when the voltage boost circuit is not required to work, the logic control circuit can control the switch device to turn on the current path. Therefore, charging protection for the battery electric core and a bypass function for the voltage boost circuit can be implemented through control that is performed on the switch device by the logic control circuit, without through multiple switch devices. Therefore, the number of switch devices can be reduced, so that additional impedance can be reduced and working efficiency can be improved.

In addition, because the number of switch devices can be reduced, space of a PCB can be saved, so that costs of a device and a single board can be lowered.

FIG. **4** is a schematic block diagram of a user equipment according to an embodiment of the present invention. The user equipment (User Equipment, UE) **400** shown in FIG. **4** includes a processor **410** and an apparatus **100**.

The apparatus **100** supplies power to the processor **410**.

The apparatus **100** may include a battery electric core **101**, a switch device **102**, a voltage boost circuit **103**, a state detection circuit **104**, and a logic control circuit **105**. The switch device **102** is connected in a current path **106** of the battery electric core **101**. The voltage boost circuit **103** is connected in parallel to the current path **106**, and is configured to boost an output voltage of the battery electric core **101**. The state detection circuit **104** is configured to detect a state of the battery electric core **101** and a state of the apparatus **100**, and generate a state signal, where the state signal is used to indicate the state of the battery electric core **101** and the state of the apparatus **100**. The logic control circuit **105** is configured to receive the state signal from the state detection circuit **104**, and control the switch device **102** and the voltage boost circuit **103** according to the state signal, when the battery electric core **101** is in an abnormal charging state, control the switch device **102** to turn off the current path **106**, and when the voltage boost circuit **103** is not required to work, control the switch device **102** to turn on the current path **106**.

Reference may be made to processes of the embodiments shown in FIG. **1** to FIG. **3** for other functions and operations of the apparatus **100**, which are not described herein again in order to avoid repetition.

It should be understood that, in this embodiment of the present invention, the UE, also referred to as a mobile terminal (Mobile Terminal, MT) or a mobile user equipment, may be a mobile terminal, for example, a mobile phone (or referred to as a "cellular" phone) and a computer that has a mobile terminal, for example, may be a portable, pocket, or handheld mobile device, or a mobile device built in a computer or mounted in a vehicle, which is not limited in this embodiment of the present invention.

In this embodiment of the present invention, when the battery electric core is in an abnormal charging state, the logic control circuit can control the switch device to turn off the current path, and when the voltage boost circuit is not required to work, the logic control circuit can control the switch device to turn on the current path. Therefore, charging protection for the battery electric core and a bypass function for the voltage boost circuit can be implemented through control that is performed on the switch device by the logic control circuit, without through multiple switch devices. Therefore, the number of switch devices can be reduced, so that additional impedance can be reduced and working efficiency can be improved.

In addition, because the number of switch devices can be reduced, space of a PCB can be saved, so that a cost of the UE can be lowered.

FIG. **5** is a schematic flowchart of a power supply method according to an embodiment of the present invention.

510: A state detection circuit detects a state of a battery electric core and a state of a power supply apparatus, and generates a state signal, where the state signal is used to indicate the state of the battery electric core and the state of the apparatus.

520: A logic control circuit receives the state signal from the state detection circuit, and controls a switch device and a voltage boost circuit according to the state signal, when the battery electric core is in an abnormal charging state, controls the switch device to turn off a current path of the battery electric core, and when the voltage boost circuit is not required to work, controls the switch device to turn on the current path.

The apparatus includes the state detection circuit, the battery electric core, the voltage boost circuit, the switch device, and the logic control circuit. The switch device is connected in the current path. The voltage boost circuit is connected in parallel to the current path. The voltage boost circuit is configured to boost an output voltage of the battery electric core.

In this embodiment of the present invention, when the battery electric core is in an abnormal charging state, the logic control circuit can control the switch device to turn off the current path, and when the voltage boost circuit is not required to work, the logic control circuit can control the switch device to turn on the current path. Therefore, charging protection for the battery electric core and a bypass function for the voltage boost circuit can be implemented through control that is performed on the switch device by the logic control circuit, without through multiple switch devices. Therefore, the number of switch devices can be reduced, so that additional impedance can be reduced and working efficiency can be improved.

In addition, because the number of switch devices can be reduced, space of a PCB can be saved, so that costs of a device and a single board can be lowered.

Optionally, as an embodiment, when the state signal indicates that the battery electric core is in an over-voltage state or when the state signal indicates that the battery electric core is in an over-current charging state, the logic control circuit may turn off the voltage boost circuit and control the switch device to turn off the current path.

Optionally, as another embodiment, when the state signal indicates that the output voltage of the battery electric core is greater than or equal to a voltage threshold and indicates that an output voltage of the apparatus is greater than or equal to the voltage threshold, the logic control circuit may turn off the voltage boost circuit and control the switch device to turn on the current path.

Optionally, as another embodiment, when the state signal indicates that the output voltage of the battery electric core is smaller than a voltage threshold and indicates that the output voltage of the apparatus is smaller than the voltage threshold, the logic control circuit may turn on the voltage boost circuit and control the switch device to turn off the current path.

Optionally, as another embodiment, when the state signal indicates that the output voltage of the battery electric core is smaller than a voltage threshold and indicates that the output voltage of the apparatus is greater than or equal to the voltage threshold, the logic control circuit may turn on an isolation charging circuit, turn off the voltage boost circuit, and control the switch device to turn off the current path, where the isolation charging circuit is configured to charge the battery electric core and isolate the output voltage of the battery electric core from the output voltage of the apparatus.

Optionally, as another embodiment, an example of a logic truth table of a logic control module is shown in Table 1.

FIG. **6** is a schematic flowchart of a process of a power supply method according to an embodiment of the present invention.

601: An apparatus is in an initial state.

602: Acquire an output voltage of a battery electric core.

For example, a first voltage detection circuit may detect the output voltage of the battery electric core.

603: Acquire an output voltage of the apparatus.

For example, a second voltage detection circuit may detect the output voltage of the apparatus.

604: Acquire a charging current of the battery electric core.

605: Determine whether the charging current acquired in step **604** is smaller than an allowed maximum charging current.

If the charging current is smaller than the allowed maximum charging current, it may indicate that the battery electric core is in a normal charging state, and then proceed to step **606**.

If the charging current is greater than or equal to the allowed maximum charging current, it may indicate that the battery electric core is in an abnormal charging state, and then proceed to step **608**.

In step **608**, a switch device, a voltage boost circuit, and an isolation charging circuit may be turned off, so as to protect the battery electric core.

606: If the charging current is smaller than the allowed maximum charging current, determine whether the output voltage of the battery electric core is greater than a low voltage threshold.

If the output voltage of the battery electric core is greater than the low voltage threshold, it may indicate that the battery electric core is in a normal voltage state, and then proceed to step **607**.

If the output voltage of the battery electric core is smaller than or equal to the low voltage threshold, it may indicate that the battery electric core is in a low voltage state, and then proceed to step **610**.

607: If the output voltage of the battery electric core is greater than the low voltage threshold, determine whether the output voltage of the battery electric core is smaller than an over-voltage threshold.

If the output voltage of the battery electric core is greater than or equal to the over-voltage threshold, it may indicate that the battery electric core is in an over-voltage state, and then proceed to step **608**, where the switch device, the voltage boost circuit, and the isolation charging circuit are turned off, so as to protect the battery electric core.

If the output voltage of the battery electric core is smaller than the over-voltage threshold, proceed to step **609**.

In step **609**, because the battery electric core is in a normal charging/discharging state, that is, the battery electric core is in a normal voltage state and the output voltage of the battery electric core does not need to be boosted, a current path where the switch device is located may be turned on by turning on the switch device, and the voltage boost circuit and the isolation charging circuit may be turned off, so as to bypass the voltage boost circuit.

610: If the output voltage of the battery electric core is smaller than or equal to the low voltage threshold, determine whether the output voltage of the apparatus is greater than a charging judgment threshold.

If the output voltage of the battery electric core is smaller than or equal to the low voltage threshold and the output voltage of the apparatus is greater than the charging judgment threshold, proceed to step **611**.

In step **611**, the battery electric core needs to enter and remain in a low voltage charging state, the switch device and the voltage boost circuit are turned off, and the isolation charging circuit is turned on.

If the output voltage of the battery electric core is smaller than or equal to the low voltage threshold and the output voltage of the apparatus is smaller than or equal to the charging judgment threshold, proceed to step **612**.

In step **612**, the battery electric core is in a low voltage discharging state; and in order to ensure that the output voltage of the apparatus can enable a load to work normally, the output voltage of the battery electric core needs to be boosted, and then the voltage boost circuit may be turned on and the switch device and the isolation charging circuit may be turned off.

In this embodiment of the present invention, when the battery electric core is in an abnormal charging state, the logic control circuit can control the switch device to turn off the current path, and when the voltage boost circuit is not required to work, the logic control circuit can control the switch device to turn on the current path. Therefore, charging protection for the battery electric core and a bypass function for the voltage boost circuit can be implemented through control that is performed on the switch device by the logic control circuit, without through multiple switch devices. Therefore, the number of switch devices can be reduced, so that additional impedance can be reduced and working efficiency can be improved.

Persons of ordinary skill in the art should be aware that, in combination with the examples described in the embodiments disclosed in this specification, units and algorithm steps can be implemented by electronic hardware, or a combination of computer software and electronic hardware. Whether the functions are executed by hardware or software depends on particular applications and design constraint conditions of the technical solutions. Persons skilled in the art may use different methods to implement the described functions for each particular application, but it should not be considered that the implementation goes beyond the scope of the present invention.

It may be clearly understood by persons skilled in the art that, for the purpose of convenient and brief description, for a detailed working process of the foregoing system, apparatus and unit, reference may be made to the corresponding process in the method embodiments, which is not described herein again.

In the embodiments provided in the present application, it should be understood that the disclosed system, apparatus, and method may be implemented in other manners. For example, the described apparatus embodiments are merely exemplary. For example, the unit division is merely logical function division and may be other division in actual implementation. For example, multiple units or components may be combined or integrated into another system, or some features may be ignored or not performed. In addition, the displayed or discussed mutual couplings or direct couplings or communication connections are implemented through some interfaces. The indirect couplings or communication connections between the apparatuses or units may be implemented in electronic, mechanical, or other forms.

The units described as separate parts may or may not be physically separate, and parts displayed as units may or may not be physical units, may be located in one position, or may be distributed on multiple network units. A part or all of the units may be selected according to an actual need to achieve the objectives of the solutions in the embodiments.

In addition, functional units in the embodiments of the present invention may be integrated into one processing unit, or each of the units may exist alone physically, or two or more units are integrated into one unit.

When the functions are implemented in the form of a software functional unit and sold or used as a separate product, the functions may be stored in a computer-readable storage medium. Based on such an understanding, the technical solutions of the present invention essentially, or the part contributing to the prior art, or part of the technical solutions may be implemented in the form of a software product. The computer software product is stored in a storage medium, and includes several instructions for instructing a computer device (which may be a personal computer, a server, a network device, and the like) to execute all or part of the steps of the method described in the embodiment of the present invention. The storage medium includes: any medium that can store program codes, such as a USB flash disk, a removable hard disk, a read-only memory (ROM, Read-Only Memory), a random access memory (RAM, Random Access Memory), a magnetic disk, or an optical disk.

The foregoing descriptions are merely specific embodiments of the present invention, but are not intended to limit the protection scope of the present invention. Any variation or replacement readily figured out by persons skilled in the art within the technical scope disclosed in the present invention shall all fall within the protection scope of the present invention. Therefore, the protection scope of the present invention shall be subject to the protection scope of the claims.

What is claimed is:

1. A power supply apparatus, comprising:

a battery electric core, a switch device, a voltage boost circuit, a state detection circuit, and a logic control circuit, wherein:

the switch device is connected in a current path of the battery electric core;

the voltage boost circuit is connected in parallel to the current path, and is configured to boost an output voltage of the battery electric core;

the state detection circuit is configured to:

detect a state of the battery electric core and a state of the apparatus, and

generate a state signal, wherein the state signal is used to indicate the state of the battery electric core and the state of the apparatus; and

the logic control circuit is configured to:

receive the state signal from the state detection circuit, and

control the switch device and the voltage boost circuit according to the state signal, such that:

when the battery electric core is in an abnormal charging state, control the switch device to turn off the current path, and

when the voltage boost circuit is not required to work, control the switch device to turn on the current path.

2. The apparatus according to claim 1, wherein the logic control circuit is configured to, when the state signal indicates that the battery electric core is in an over-voltage state or when the state signal indicates that the battery electric core is in an over-current charging state, turn off the voltage boost circuit and control the switch device to turn off the current path.

3. The apparatus according to claim 1, wherein the logic control circuit is configured to, when the state signal indicates that the output voltage of the battery electric core is smaller than a voltage threshold and indicates that an output voltage of the apparatus is smaller than the voltage threshold, turn on the voltage boost circuit and control the switch device to turn off the current path.

4. The apparatus according to claim 1, wherein the logic control circuit is configured to, when the state signal indicates that the output voltage of the battery electric core is greater than or equal to a voltage threshold and indicates that an output voltage of the apparatus is greater than or equal to the voltage threshold, turn off the voltage boost circuit and control the switch device to turn on the current path.

5. The apparatus according to claim 1, further comprising:

a driving circuit, connected to the switch device, wherein the driving circuit adopts a field-effect transistor push-pull structure, and wherein

the logic control circuit is specifically configured to control the switch device through the driving circuit.

6. The apparatus according to claim 1, further comprising an isolation charging circuit connected in parallel to the current path and the voltage boost circuit, and wherein the isolation charging circuit is configured to charge the battery electric core and isolate the output voltage of the battery electric core from the output voltage of the apparatus, and

wherein the logic control circuit is further configured to control the isolation charging circuit according to the state signal.

7. The apparatus according to claim 6, wherein the logic control circuit is configured to, when the state signal indicates that the output voltage of the battery electric core is smaller than a voltage threshold and indicates that the output voltage of the apparatus is greater than or equal to the voltage threshold, turn on the isolation charging circuit, turn off the voltage boost circuit, and control the switch device to turn off the current path.

8. The apparatus according to claim 6, wherein the voltage boost circuit, the state detection circuit, the logic control circuit, and the isolation charging circuit are integrated in one chip.

9. The apparatus according to claim 1, wherein the state detection circuit comprises a first voltage detection circuit and a second voltage detection circuit,

wherein the first voltage detection circuit is configured to detect the output voltage of the battery electric core and compare the output voltage of the battery electric core with a voltage threshold; and

the second voltage detection circuit is configured to detect the output voltage of the apparatus and compare the output voltage of the apparatus with the voltage threshold.

10. A user equipment, comprising:

a processor; and

the power supply apparatus according to claim 1,

wherein the apparatus is configured to supply power to the processor.

11. A power supply method, comprising:

detecting, by a state detection circuit, a state of a battery electric core and a state of a power supply apparatus, and generating a state signal based on the detecting, wherein the state signal indicates the state of the battery electric core and the state of the apparatus; and

receiving, by a logic control circuit, the state signal from the state detection circuit, and controlling a switch device and a voltage boost circuit according to the state signal, such that:

when the battery electric core is in an abnormal charging state, controlling the switch device to turn off a current path of the battery electric core, and

when the voltage boost circuit is not required to work, controlling the switch device to turn on the current path,

wherein the apparatus comprises the state detection circuit, the battery electric core, the voltage boost circuit, the switch device, and the logic control circuit, and

wherein the switch device is connected in the current path, the voltage boost circuit is connected in parallel to the current path, and the voltage boost circuit is configured to boost an output voltage of the battery electric core.

12. The method according to claim 11, wherein when the battery electric core is in an abnormal charging state, the controlling the switch device to turn off the current path of the battery electric core comprises:

when the state signal indicates that the battery electric core is in an over-voltage state, turning off, by the logic control circuit, the voltage boost circuit, and controlling the switch device to turn off the current path; and

when the state signal indicates that the battery electric core is in an over-current charging state, turning off, by the logic control circuit, the voltage boost circuit, and controlling the switch device to turn off the current path.

13. The method according to claim 11, wherein when the voltage boost circuit is not required to work, the controlling the switch device to turn on the current path comprises:

when the state signal indicates that the output voltage of the battery electric core is greater than or equal to a voltage threshold and indicates that an output voltage of the apparatus is greater than or equal to the voltage threshold, turning off, by the logic control circuit, the voltage boost circuit, and controlling the switch device to turn on the current path.

14. The method according to claim **11**, further comprising: when the state signal indicates that the output voltage of the battery electric core is smaller than a voltage threshold and indicates that an output voltage of the apparatus is smaller than the voltage threshold, turning on, by the logic control circuit, the voltage boost circuit, and controlling the switch device to turn off the current path.

15. The method according to claim **11**, further comprising: when the state signal indicates that the output voltage of the battery electric core is smaller than a voltage threshold and indicates that the output voltage of the apparatus is greater than or equal to the voltage threshold, turning on, by the logic control circuit, an isolation charging circuit, turning off the voltage boost circuit, and controlling the switch device to turn off the current path, wherein the isolation charging circuit is configured to charge the battery electric core and isolate the output voltage of the battery electric core from the output voltage of the apparatus.

16. The method according to claim **11**, wherein a logic truth table of the logic control circuit is:

State Signal			Control Signal		
STA1	STA2	STA3	CO1	CO2	CO3
1	1	0	1	0	0
0	0	0	0	1	0
0	1	0	0	0	1
X	X	1	0	0	0
H	X	0	0	0	0

wherein when STA**1** is “1”, it indicates that the output voltage of the battery electric core is greater than or equal to a voltage threshold, when STA**1** is “0”, it indicates that the output voltage of the battery electric core is smaller than the voltage threshold, when STA**1** is “X”, it indicates that a control signal is irrelevant with STA**1**, and when STA**1** is “H”, it indicates that the battery electric core is in an over-voltage state;

when STA**2** is “1”, it indicates that the output voltage of the apparatus is greater than or equal to the voltage threshold, when STA**2** is “0”, it may indicate that the output voltage of the apparatus is smaller than the voltage threshold, and when STA**2** is “X”, it indicates that a control signal is irrelevant with STA**2**;

when STA**3** is “1”, it indicates that the battery electric core is in an over-current charging state, and when STA**3** is “1”, it indicates that the battery electric core is in a normal charging current state;

when CO**1** is “1”, it indicates that the switch device is controlled to turn on the current path, and when CO**1** is “0”, it indicates that the switch device is controlled to turn off the current path;

when CO**2** is “1”, it indicates that the voltage boost circuit is turned on, and when CO**2** is “0”, it indicates that the voltage boost circuit is turned off; and

when CO**3** is “1”, it indicates that the isolation charging circuit is turned on, and when CO**3** is “0”, it indicates that the isolation charging circuit is turned off.

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